§28. Modular Coil Design for New CHS-qa Configuration

Shimizu, A. (Nagoya Univ.), Okamura, S., Isobe, M., Suzuki, T., Nishimura, S., Matsuoka, K., Watari, T.

The latest optimization procedure for CHS-qa configuration includes the evaluation of properties of ballooning stability and alpha particle's confinement. When additional advantageous properties are added to the original quasi-axisymmetric configuration, the geometry of the plasma boundary tends to have large curvature and to become difficult to reproduce by modular coils. For two new qa-configurations, the modular coil systems are optimized by using the NESCOIL code.

"2b32" is a qa-configuration where ballooning instability is suppressed. Toroidal periodic number is 2, aspect ratio is 3.2, and major radius is 1.5 m. The aspect ratio of "2b32" is lower than that of the previous qa-configuration, "2w39", and this smaller aspect ratio makes it difficult to design a modular coil system. In Fig. 1, the modular coil system for "2b32" is shown. The minimum curvature radius of modular coils is 25 cm and the minimum distance between modular coils is 21.5 cm. Both of these figures are smaller than those of modular coil system for "2w39" (28 cm and 22 cm respectively for this configuration). The Poincare plot of the magnetic field produced by the modular coil system for "2b32" is shown in Fig. 2. The geometry of original "2b32" configuration is also shown with solid line. The magnetic surface is reproduced well by modular coils. The iota value at the plasma boundary is not rational, therefore clear (not chaotic) magnetic surface exists at the plasma edge and larger volume than "2w39" is valid for plasma confinement ("2w39" magnetic configuration has the rational iota value ~ 0.4 at the plasma edge and large islands exist there.).

"2a36" is a qa-configuration where alpha particle confinement is improved. Aspect ratio is 3.6, which is similar value to that of "2w39", however the geometry of plasma boundary is rather complicated. The plasma boundary cross section at 45 degree of toroidal angle has large curvature around the bottom edge. In Fig.3, the Poincare plot of magnetic field produced by the optimized modular coil system for "2a36" is shown. The geometry of original "2a36" configuration is also shown with solid line. Modular coils produce the roughly same magnetic surface as the original one, however because of islands (which correspond to iota = 0.4) the discrepancy is large at the boundary.

It is considered that the original plasma boundary shape may be distorted because of these islands in the optimization process by using VMEC, therefore the relaxation of complicated boundary geometry is needed to produce a good modular coil system for 2a36 configuration.

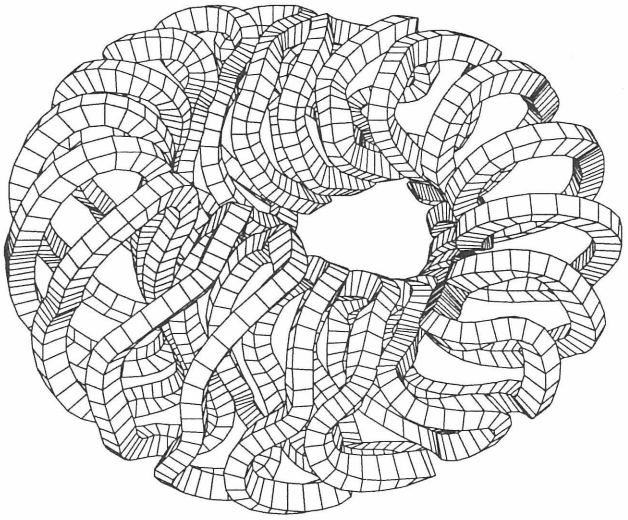

Fig. 1 The modular coil system for "2b32". This system consists of 20 modular coils (5 different types).

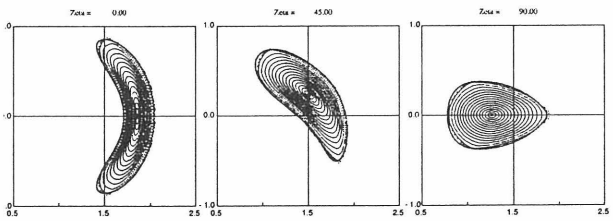

Fig. 2 The Poincare plot of magnetic field produced by the modular coil system in Fig. 1. The geometry of original boundary configuration is shown with solid line.

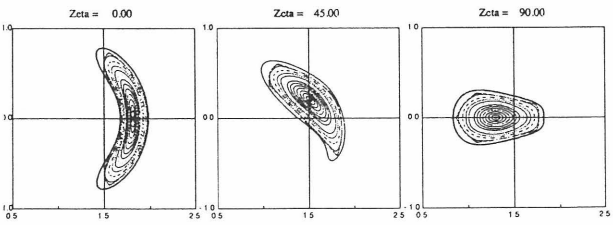

Fig. 3 The Poincare plot of magnetic field produced by the optimized modular coil system for "2a36" configuration.